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ABSTRACT

Through its grants, the National Science Foundation sponsors workshops that inform faculty of current topics in computer science. Such a workshop, entitled, "Developing Multimedia-based Interactive Laboratory Modules for Computer Science," was given July 27-August 6, 1998, at Illinois State University at Normal. Each participant was expected to design and implement a small part of a laboratory module. This paper describes what five of the faculty members who participated have done with the knowledge obtained from the workshop. (Contains 22 references.) (Author/MES)

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Integrating Multimedia Techniques into CS Pedagogy

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G.H.Marks

Abstract: Through its grants, the National Science Foundation sponsors workshops that inform faculty of current topics in Computer Science. Such a workshop, entitled, "Developing Multimedia-based Interactive Laboratory Modules for Computer Science", was given July 27 - August 6, 1998, at Illinois State University in Normal, Illinois. Each participant was expected to design and implement a small part of a laboratory module. This paper describes what some of the faculty members who participated in the workshop have done with the knowledge obtained from the workshop.

1. Introduction

The five authors met at an 11-day multimedia workshop sponsored by the National Science Foundation and hosted by Dr. Dean Sanders and Dr. Janet Hartman of the Computer Science Department at Illinois State University in Normal, during summer of 1998. After participating in intensive all day classes together, we spent the evenings in the multimedia lab applying what we learned each day. We also ate breakfast, lunch and dinner together, and checked out Normal, Illinois together during the weekend, all the time exchanging ideas, arguing and laughing together. Having shared a wonderful learning experience, we made a pact to meet again to share the results our attempts to apply our newly acquired knowledge to courses that we teach in and to new course development. Devoting 100 percent of our time to discover what multimedia [Vaughan 1996] was all about with interested faculty was an ideal way to learn about multimedia [Walsh 1995].

2. Ahmad Nasri

Recursive Subdivision is receiving a great deal of attention in Computer Graphics for modeling and animation. It is also becoming an important component in courses such as computer-aided geometric design (CAGD). The nature and the diversity of these techniques require the development of illustrative tools that help students to digest the ideas, interactively manipulate shapes and even explore new techniques. Such a technique is defined by a set of rules that takes in a configuration and generates another subdivided one. Inspired by the NSF multimedia workshop,

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we have begun implementing a multimedia course in computer-aided geometric design, which we expect to be an essential tool in our CAGD course. Students will be able to use the system in various ways such as:

- Visualize how a set of rules leads to a limit curve or a surface.
- Exploring ways to alter the subsequent subdivided configurations to deform the limiting shape.
- Interrogating subdivision curves or surfaces such as surface/surface intersection.
- Visualize how to compute moments such as volumes, center of mass and inertia tensors for physically based animation. Several tools are developed using Visual C++ which are added to the Multimedia parts for interactive use.

3. Anne-Louise Radimsky

Many students have difficulty with the abstract concepts associated with data structures. I have always believed that concrete analogies and visualization of the algorithms involved would help those students understand better the ideas presented. In particular, computer animation is a powerful tool to display in a clear manner the effects of the execution of a piece of code on the representation of a structure. Several attempts at having graduate students develop such animations have met with mixed results.

During the workshop we were presented with two powerful systems designed to produce animation: Asymetrix Toolbook and Macromedia Director. They use different paradigms. The first relies on an approach similar to that of Microsoft Powerpoint., the second is based on the concept of "actors" which can be brought into a score at different times to create a scene in a play. I chose ToolBook, both because it seemed better suited for the text-based animation I had in mind, and also because it was available on my campus.

I first created a prototype using Powerpoint. This allowed me to determine the screens sequence and the visual components needed. It proved very useful. It was easy to produce and allowed the instructors to offer suggestions on the flow of the presentation and the screens design. My goal was to illustrate the insertion of a new element in a linked list implemented with simulated pointers (i.e. using an array of nodes). As the code is executed the changes to the array are displayed.

I have added some additional operations and, with the precious help of a member of the campus media department, greatly improved the presentation. Although this individual does not have the background required to understand the substance of the algorithm, his input and experience has been invaluable in improving the appearance of the system.

My plans are to continue to develop modules for additional operations and other list representations. Ultimately, I plan to provide this material on the web for students to use in self-paced mode. Judging by the number of sites providing various kinds of multi-media resources for teaching computer science there is clearly a strong interest in many quarters for such educational material. The California State University system is also strongly encouraging the use of web-based multimedia systems to support delivery of instruction.

4. Bon K. Sy

In the last few years we have explored the possibility of employing multi-media technology to enhance teaching and learning science and technology. This is a result of the NSF Scientific Visualization workshop (1997) in Atlanta, Georgia, and the NSF Multimedia technology workshop (1998) in Bloomington/Normal, Illinois. Our focus is on using multi-media to support instructional activities. Learning based on multi-sensory channels will be an integral part of our curriculum in training students majoring in computer science and related science disciplines.

There are three major components of our project on employing multi-media technology to enhance science education. The first component is the development of a computer controlled instrumentation laboratory and curriculum enhancement under the support of a current NSF ILI grant. The focus is to introduce students with computer based instrumentation for automatic data acquisition and data analysis; e.g., using temperature and humidity sensors to collect weather data for predicting possible thunderstorm. Recently, a new course CS86 has been developed as a vehicle to implement the curriculum. Our goal is to use this vehicle to attract students to major in science and technology, as well as to retain them in the disciplines. This new course was offered the first time in the fall semester of 1998. Our initial success has led to the permission by the administration to offer the course again this coming fall semester.

The second component is our research on the learning methodologies for machine and human learners. We have investigated a pattern-based learning principle that integrates the rigor of mathematical based scientific analysis with abstract visualization of difficult science concepts. We are in the process of harnessing and integrating decision support tools developed from research laboratories with commercially available analytical tools. One specific component is the integration of a Bayesian decision support system developed by us using ActiveX technology with existing analytical tool S-PLUS.

Another component of the project is to create a scientific data depository based on Oracle server as the back-end, and to integrate it with the integrated analytical tools just mentioned. Further details can be found in another paper to be published in this conference proceeding [Sy, B.1999]. Several sets of courseware that implement the pattern-based learning principle have already been developed and will be demonstrated during the conference presentation.

The third component is the activities related to the two workshops mentioned earlier. The focus is to identify multi-media tools that will be effective for developing courseware for educational purposes, as well as Computer Based Training (CBT) packages, to support and enhance learning. Specific activities will include the development of CBT packages to illustrate the use of complex software systems effectively. A sample example developed in the NSF Multi-media technology workshop is available on the web via "http://tweety.geol.qc.edu/nsf/courseware/". We intend to use this component of the project as a vehicle to produce and prepare (electronic) documents for not only local distribution, but also wide dissemination over the Internet to other parties who may be interested in our projects.

Now we shall present our experience on the development of web deployable courseware for this project. The targeted audience of the courseware is the students of two courses: (a) Science Problem Solving using Computing Tools (CS86) --- a course for freshman and sophomore students in general science, and (b) Algorithms based on Probability Methods (CS762) --- a course for undergraduate senior and graduate students in Computer Science.

The development of web deployable courseware consists of three tasks: (a) content material development, (b) media presentation and application feature, and (c) dissemination. Currently we focus on developing courseware for content materials that involve mathematically oriented concepts, in particular, those concepts that are difficult to our students; e.g., system equations for projectile motion in CS86, or the computational geometry of hyper-tetrahedron that encompasses all possible discrete multi-variant probability models in CS762. An important consideration of our courseware development is the visualization feature for a student to explore visually the mathematical structure behind a difficult concept. Another important consideration is the transportability of the courseware for a wide dissemination beyond our local community.

In this project, the pedagogy behind the content material development is an integral part. Many science concepts are mathematically oriented; e.g., the fundamental principle in electromagnetic is stated in terms of Maxwell's equation [Paul et al. 1997], the behavior of an electron can be stated in terms of Dirac equation [Hawking 1993]. As a result, science concepts are often taught like mathematics, but with attached meanings as they are related to our physical reality. Yet for many students the details of mathematics, as opposed to the structure of a concept behind the mathematics, could be a distraction that hinders the comprehension of the concept. Thus the ability to visualize and formulate a structure mentally from the mathematical details is an important skill to understand many science concepts that are mathematically oriented.

As noted from our students, math and science understanding are often related to the ability to visualize. This often left out many students to engage in science and technology. Fortunately, new and better computer tools have become available for scientific computing and are widely used in industry [Johnson 1997], [Oppenheimer 1997]. Improvements are now at the point where these tools could be integrated into the undergraduate science curriculum. These new tools may help to ease that gap by being an aid to that visualization.

These new tools come with electronic books that provide 'live' formulas where the data can be manipulated, graphed, or even animated [Spiegel et al. 1998], [Nelson et al. 1995] , and [Spiegel et al. 1989]. This is not just a textbook in an electronic form, but a new media providing new modalities for learning. Integrating new modalities with traditional text-based modality is particularly well suited for the pattern-based learning approach mentioned earlier [Sy, B.1999], which is a significant and integral part of our project on enhancing science and technology education. Using these new modalities, students can apply the conceptual learning tool --- pattern-based learning --- to gain a greater insight into visual reasoning behind the numbers and their mathematical relationship. By increasing the number of ways a student can learn scientific formulas, we can make science education more inclusive.

Many famous scientific publishers are producing learning materials in this new media. For example, Schaum's Interactive Outline Series based on Mathcad allows students to run the outlines electronically [Edminister 1994]. Students can access formulas with the click of their mouse, and interact with the formulas while grasping the subject

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matter. In our project, we have developed an array of courseware using Mathcad, as well as courseware based on ActiveX technology.

Each courseware is web accessible in the Internet with the Mathcad/MathConnex plug-in that takes the advantage of OLE automation technology. Each courseware being developed is focused on a special topic/concept in either CS86 or CS762 mentioned earlier. A set of courseware already developed for our CS86 and CS762 can be found in our web site http://tweety.geol.qc.edu/nsf/demo. The details for accessing the courseware will be detailed during the conference presentation.

5. Richard Jou

My "Computer Graphics" class for the Spring Semester of 99 includes a multimedia project using some of the software tools that I was exposed to during the summer NSF multimedia workshop. This is a junior/senior class covering mainly geometric modeling and algorithm designs of the basic principle of computer graphics. The basic software tools used for this class include C, C++ and a graphics library.

I am also designing Web-based courses where most of the class materials, homework assignments, and project assignment are uploaded onto our Web server, where students can access them through a Web browsers and submit their homework through E-mail. Each semester allows me to re-evaluate my course content available on the Web through student successes/failures and feedback . I am currently updating my Web based teaching materials to improve them.

6. Sandra Honda Adams

At the workshop I was pleasantly surprised to see how easy it was to prepare multimedia slides using Powerpoint 98. We are presenting workshops in Powerpoint to the faculty here to show them how interactive, non-linear presentations can be created using this authoring tool. Buttons that trigger video, sound or music, and navigation to other slides can easily be incorporated into Powerpoint slides used for lectures. Director workshops will also be given to faculty at our institution and for area high school faculty. Five new projections units have been added to classrooms to help encourage the use of technology in the classroom.

The students are able to create multimedia animations [Gross et al. 1999] using Macromedia Director's embedded text and paint programs, and embellished their work with recorded sounds. Thanks to the NSF workshop I have added segments on video, photo [Sawyer & Pronk 1997] and audio capture [Seaman & Cline 1996] and manipulation to these classes by including additional segments on Photoshop [Quinn et al. 1997], CoolEdit and scanning to our existing multimedia courses. The video component will allow the student to modify a portion of a personal VCR tape, creating short segments to include in their multimedia productions. The scanning component will allow students to scan photographs [Aaland 1996] for PhotoShop manipulations. CoolEdit will allow students to record and manipulate speech and music. The added material will delight students as they deploy their Director movies for the web by preparing their movies for streaming shockwave. [Yeaman & Dawson 1996]

I have been spending my time learning other software to develop new classes for our non-major courses and for our Info Tech major. We have many employers who are calling for Web and multimedia developers and designers [Fromm 1995]. Their requirements are constantly growing and students wanting these positions need to know other Web based software. We have developed and are constantly re-designing our Web Design course [Siegel 1997], [Lemay 1997]. We are also planning to add Authorware [Roberts 1997], Flash [Plant 1998], and Dreamweaver to our Multimedia and Web Design Courses.

We are experiencing an increase in the number of students enrolling in our new Information Technology MS program. Graduates of other programs are also interested in learning more about Information Technology. They are very interested in joining startup companies that are developing e-commerce or companies that are developing or maintaining Internet or Intranet sites.

7. Conclusions

Each faculty member has utilized some of the tools that were presented and have implemented them in a variety of ways in their courses and curriculum. The NSF multimedia workshop was an excellent opportunity to learn something new and meet others who were curious about learning and using interactive multimedia and web technology in the classroom.

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